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MATHEMATICS CLUSTERS IN SELECTED AREAS OF VOCATIONAL EDUCATION, REPORT NUMBER 8.

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IDENTIFICATIONS WERE MADE OF THE MATHEMATICAL KNOWLEDGES COMMONLY USED IN OCCUPATIONS MOST READILY SUITABLE FOR NONCOLLEGE-BOUND YOUTH. TASK ITEMS FROM QUESTIONNAIRES USED IN OFFICE OCCUPATIONS, GENERAL MERCHANDISING, BUILDING TRADES, ELECTRONICS, FOOD SERVICE, CHILD CARE, AND AGRICULTURE STUDIES WERE EXAMINED FOR MATHEMATICAL KNOWLEDGE CONTENT. FIVE CLUSTERS OF MATHEMATICS KNOWLEDGES WERE FOUND TO BE USEFUL IN ALL THE JOB AREAS STUDIED. THESE CLUSTERS WERE (1) OPERATIONS WITH FRACTIONS, (2) OPERATIONS WITH DECIMALS, (3) CONVERSION OF FRACTIONS TO DECIMALS, (4) CONCEPT OF PERCENTAGE, AND (5) RATIO AND PROPORTION. STUDY RESULTS WERE CONSIDERED TENTATIVE. THIS VOLUME REPRESENTS PART 8 OF THE 13-PART FINAL REPORT ON THE VOCATIONAL-TECHNICAL EDUCATION RESEARCH AND DEVELOPMENT PROJECT OF WASHINGTON STATE UNIVERSITY. RELATED VOLUMES ARE ED 010 652 THROUGH ED 010 664. (JH)

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MATHEMATICS CLUSTERS IN SELECTED AREAS OF VOCATIONAL EDUCATION

November 30, 1966

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MATHEMATICS CLUSTERS IN SELECTED AREAS OF VOCATIONAL EDUCATION

Project No. ERD-257-65
Contract No. OE-5-85-109
Report No. 8

by
Harold F. Rahmlow and Leonard Winchell

November 30, 1966

The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

Department of Education, Washington State University, Pullman, Washington
State Board for Vocational Education, Olympia, Washington

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INTRODUCTION

Background and Rationale

One major purpose of our research is to identify clusters of knowledge and competencies most likely to maximize the career-long occupational opportunity, competence, and choice on non-college bound youth in an evolving technological society.

Our research is rooted in the philosophic premise that occupational freedom involves both informed choice of alternatives and competence to work effectively. The economy needs constantly larger numbers of workers possessing new capabilities. But youth are free to ponder only the occupational choices they perceive. They are free to perform only the kinds of work for which they acquire competence.

Choice and acquisition of competence may be needlessly impaired by limited outlooks and motivations. For those reasons, studies of occupational perceptions, aspirations constitute interrelated dimensions of our research.

The objective of our clusters research is to obtain facts about what major types of tasks are actually performed in occupations most likely to provide employment opportunity for substantial percentages of non-college bound youth and to identify major types of knowledge most likely to prepare them for such work. On the basis of Bureau of Labor Statistics projections, the following occupational areas were selected for study: office, general merchandise retailing, building trades, electronics, food service, and child care.

To obtain task and knowledge data for clustering, the staff, in consultation with employers, employees, and vocational teachers, prepared questionnaire check lists designed to identify specific major tasks actually performed by workers in each of the occupational areas listed above.

Questionnaires were designed to obtain from employees data on age, sex, major types of tasks presently performed, length of time on present job, and other types of work done in the past five years.

Those questionnaires have been administered to representative samples of workers in each occupational area. To maximize the predictive value of data, questionnaires were administered to employees in modern firms in which the tasks performed are most likely to represent those prevailing in the foreseeable future.

Results provide data on (1) combinations of major tasks groups of workers on a construction job or in a firm or agency presently perform, (2) combinations of major tasks performed on entry jobs, and (3) combinations of tasks generally performed by workers with various degrees of experience, and (4) some data on 5-year combinations of worker experience.

From analysis of the above data, we have obtained up-to-date facts about combinations of major tasks performed by major categories of workers.

Knowledges associated with performance of each task are being identified by juries of employees, supervisors, and vocational teachers.

Both task and knowledge items are being coded so various patterns of relationships can be identified rapidly by computer.

From analysis of the above data, we are obtaining definitions of both tasks and knowledges involved in entry jobs and in positions into which workers can move as they get experience. We are identifying (1) some clusters of knowledge useful within each occupational area and (2) some clusters that are commonly useful in two or more areas.

Facts about currently useful tasks and knowledge are being supplemented by studies of ways they will be affected by equipment, processes, and materials now being developed by leading-edge industries.

Objective and Hypothesis

The objective of this phase of the project is to conceptualize and identify mathematical knowledges commonly useful for work in occupations most likely to provide employment for substantial numbers of non-college bound youth. On the basis of U. S. Bureau of Labor Statistics projections, occupations selected for study include office, retail sales, building trades, electronics, food service, and child care.

It is hypothesized that some clusters of mathematical knowledge can be identified as essential for entry and later-career work within and among those occupations. It is assumed that if such is the case, instruction that helps youth acquire such knowledge will increase their capabilities to begin work and to pursue further training essential for adaptability and upward mobility.

Related Research

A survey conducted by the President's Committee on Scientists and Engineers (4) revealed that the scope of mathematics was the most critical determinant for both level and quality of technological curriculum. Observations by mathematics teachers (5) who have worked in industry reveal a significant need for employees who have knowledge of basic mathematics and skill to apply concepts to problems in a variety of situations. The introduction of a report of mathematics authorities working in schools and industry provides evidence regarding the vocational importance of mathematics today (6):

> There is no disagreement today--nor will there be in the foreseeable future--on the vital importance of mathematics, both to the scientist, engineer, or other specialist called upon

> to use mathematics in his work, and to the intelligent layman in his everyday life. Mathematical education, to fulfill the needs of an advanced and advancing community, must be under continual scrutiny and undergo constant change, and it is the responsibility of all mathematicians, working in university, school or industry, to concern themselves with the problem of keeping mathematical education vital and up-to-date.

Other studies have identified some commonalities of occupationally useful mathematics knowledge. Maley (3) discovered that the routine arithmetic operations of addition, subtraction, multiplication, and division were common to many areas in the construction industry. Laws and Silvius (2) found in a study of technicians that arithmetic skills predominated the mathematics knowledges required. They also found a need for some knowledges in algebra, geometry, trigonometry, and calculus to a minor degree. However, it must be recognized that this study concerned itself with technicians whose qualifications would normally be beyond the high school level. A study by Barlow and Schill (1) in California considered clusters of mathematics knowledges. Their study analyzed the work of electronic technicians who utilized relatively high levels of mathematics.

METHOD

Each task item in the questionnaires was carefully analyzed by a mathematics expert and practitioners who work in each occupation under study. For example, if the task pertained to bricklaying, mathematicians and building trades workers jointly identified items of mathematical knowledge essential for that task. By similar processes, mathematical knowledges related to all tasks on other questionnaires were identified. The data presented on Table I was derived from a frequency count of the task items with which each mathematical knowledge is associated.

By analyzing the items on the data-gathering instruments, the following preliminary clusters of mathematics knowledges were identified. Table I shows the frequency with which mathematics knowledges occurred on the questionnaires and the percentages of tasks requiring each knowledge.

If both fractions and decimals are required for a particular task, it was assumed that a knowledge of conversion was also necessary.

It is educationally significant that these six clusters of mathematics knowledge overlap. Numerous items are included in more than one cluster.

There are isolated instances where other mathematics knowledges such as graphing or basic statistics are useful, but these do not cluster to the degrees indicated on Table I.

RESULTS

Table I

NUMBERS AND PER CENTS OF TASKS IN SIX OCCUPATIONAL AREAS REQUIRING KNOWLEDGES OF FRACTIONS, DECIMALS, PERCENTAGE AND PROPORTION FOR PERFORMANCE *

	Office		Child Care		Building Trade		Agriculture		Retail Sales		Food Service	
	No	%	No	%	No	%	No	%	No	%	No	%
Operations with fractions	66	11.4	2	1.4	39	26	24	18.2	41	14.1	3	4.4
Operations with decimals	155	26.8	3	2.1	38	25.3	30	22.7	69	23.8	8	11.8
Conversion: fraction decimal	57	9.9	2	1.4	38	25.3	24	18.2	41	14.1	3	4.4
Concept of Percent	103	17.8	2	1.4	5	3.2	23	17.4	40	13.8	2	2.9
Ratio and Proportion	49	8.5	1	0.7	3	2.0	19	14.4	23	7.9	1	1.5

*It is assumed that ability to add, subtract, multiply and divide integers are necessary for utilization of fraction, decimal and proportion knowledges.

DISCUSSION

The preceeding results are preliminary. The clusters are based on frequency counts of task items on the data-gathering instruments and not upon actual data. Since a frequency count method was used, the preliminary clusters are maximal in nature. When actual data is collected, clusters obtained by frequency counts can be no more inclusive than those presented here. Eventually, more inclusive clusters can be identified by techniques such as factor analysis.

The relatively low percentages of child care and food service tasks requiring knowledge of fractions, decimals, percentages and proportions should not be interpreted as indications that those knowledges are unimportant. The tasks that do require such knowledge represent major portions of work performed by employees.

The data presented in this report are in agreement with the findings of Maley (3). He found that workers in the building trades were required to possess only minimal knowledges in mathematics. Because the present study considers other areas in addition to construction, it can be considered to be more general than the Maley study.

Even though this preliminary analysis does not reveal a requirement for

extensive mathematics knowledges on the part of many workers, it should not be assumed that somewhat higher levels of mathematics are not occupationally useful. The clusters noted above denote only knowledges an employee needs for his present work. In view of the facts that many tasks are becoming more technical and that technical developments force growing percentages of workers to change jobs more frequently, it can reasonably be assumed that additional mathematics competence will facilitate essential retraining, enlarge a person's opportunity for advancement within an occupation, and increase his capability to enter related occupations. A thorough investigation of these probabilities will have educational value.

CONCLUSIONS

Preliminary Conclusions

This preliminary study indicates that clusters of vocational mathematics knowledges and their present and near-future usefulness can quite precisely be identified. On a heuristic basis, these clusters provide data upon which meaningful curriculum for vocational education can be based. Obviously, such clusters also contain elements whose usefulness transcends their vocational significance.

Recommendations

Since clusters so far identified are of a preliminary nature, it is recommended that data at hand and additional data pertaining to other occupations be obtained and analyzed. When knowledge studies in the other occupational areas are completed, they can be incorporated with existing data. This will provide a more comprehensive base for clustering.

The above clusters definitions are sufficiently verified to justify inclusion in vocational education programs and to indicate the importance of developing and testing improved methods of instruction. Only by experimental teaching of clusters and evaluation of results can their educational value be ascertained.

After clusters of essential mathematics knowledges are more precisely defined, it will be useful to investigate their role in vocational curriculum enrichment. Vocational curriculum planners need more information about what knowledges, in addition to minimum essentials add most to competence and enlargement of opportunity. They also need information about the extent to which additional mathematical capabilities improve quality of work and affect mobility, advancement, and satisfaction derived from work.

Further Study Planned

Clusters: Congruent with the recommendation for further analysis of

data, plans are being made to analyze the questionnaire data. Likewise, as studies preceed in other occupational areas (eg., marine occupations, wholesaling), additional data on vocationally useful mathematics will be obtained.

Curriculum: In cooperation with the Northwest Regional Educational Research Laboratory, plans are under way to develop and evaluate curriculum based upon some of the preliminary clusters. Systems of instruction in fractions and decimals are now under development. These systems are being developed using two closely related methods. One method will utilize computer-aided instruction and the other will be utilized independently of a computer. These materials will be used experimentally at both the high school and junior college levels, and results will be evaluated.

SUMMARY

It is hypothesized that clusters of mathematical knowledges most widely useful in occupations most likely to employ substantial percentages of non-college bound youth can be more precisely identified. Approximate identification of some clusters useful in some major occupational areas has been accomplished. More precise identification of more broadly useful clusters will come from more detailed analysis of data in hand and from additional data pertaining to other occupational areas. While more data collection and analysis are in progress, work on development and testing of experimental instructional systems for teaching fractions and decimals is proceeding.

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It is hypothesized that clusters of mathematical knowledges most widely useful in occupations most likely to employ substantial percentages of non-college bound youth can be precisely identified. The objective of this study is to conceptualize and idenitfy mathematical knowledges commonly useful for work in occupations most likely to provide employment for substantial numbers of non-college bound youth.

Task items from questionnaires used in office, general merchandise retailing, building trades, electronics, food service, child care and agriculture studies were examined for mathematical knowledge content. Five clusters of mathematics knowledges were found to be useful in all the areas studied. These clusters were: operations with fractions, operations with decimals, conversion of fractions to decimals, concept of percentage, ratio and proportion.

The results of this study should be considered preliminary in nature. Further study in this area is planned. While more data collection and analysis are in progress, work on development and evaluation of experimental instructional systems for teaching concepts in the fractions and decimals clusters is proceeding.

16. RETRIEVAL TERMS (Continue on reverse)

Vocational Mathematics
Clusters of Mathematical Knowledge

17. IDENTIFIERS

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